EFFECT OF SAWDUST SPECIES AND PARTICLE SIZE ON GLUCOSE PRODUCTION

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Thesis submitted in fulfillment of the requirements for the award of the degree of

Bachelor of Chemical Engineering (Biotechnology)

Faculty of Chemical and Natural Resources Engineering

UNIVERSITI MALAYSIA PAHANG

FEBRUARY 2013

TABLE OF CONTENTS

CHAPTER 2 LITERATURE REVIEW

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

cm^{-1}	Per Centimeter
g	Grams
g/L	Grams per liters
kg	Kilogram
M	Molarity (moles/ liters)
mL	Milliliters
mm	Millimeters
mol/dm^3	Moles/ decimeter Cubed
rpm	Rotation per minute
v/w	Volume per weight
w/w	Weight per weight
α	Alpha
β	Beta
μL	Microliters
μm	Micrometer
%	Percentage
^oC	Degree Celcius

LIST OF ABBREVIATIONS

C	Carbon
DNS	Dinitrosalicylic Acid
FTIR	Fourier Transform Infrared
H	Hydrogen
HPLC	High Performance Liquid Chromatography
L	Liquid
mRNA	Messenger Ribonucleic acid
NMR	Nuclear Magnetic Resonance Spectroscopy
O	Oxygen
PAA	Peracetic Acid
S	Solid
SEM	Scanning Electron Microscopy
TGA	Thermal Gravimetric Analysis

KESAN SPESIS DAN SAIZ ZARAH HABUK KAYU SEMASA PENGHASILAN GLUKOSA

ABSTRAK

Pelupusan sisa pepejal telah menjadi cabaran besar dalam dunia hari ini. Oleh itu, tindakan segera perlu dilaksanakan untuk mengubah sisa pepejal menjadi produk yang mempunyai nilai tambah. Habuk kayu adalah salah satu jenis sisa pepejal yang boleh dihidrolisis kepada glukosa. Kajian ini menfokuskan tentang kesan spesies dan saiz zarah habuk kayu semasa penghasilan glukosa. Tiga spesies habuk kayu telah dipilih dalam kajian, iaitu *Meranti*, *Keruing* dan *Kempas*. Habuk kayu bagi setiap spesies disediakan dalam empat saiz zarah yang berbeza iaitu 160 μm, 200 μm, 315 μm dan 630 μm. Selepas beberapa langkah prarawatan untuk memperoleh semula selulosa dari habuk kayu, kaedah hidrolisis enzim telah digunakan untuk menghasilkan glukosa dari selulosa. Pemulihan selulosa yng tertinggi adalah daripada spesies *Keruing* dengan saiz zarah 630 μm. Tambahan pula, pengeluaran glukosa tertinggi selepas hidrolisis enzimatik ialah spesies *Keruin*g dengan saiz zarah 200 μm. Daripada kajian ini, adalah dicadangkan bahawa Spektroskopi Resonansi Magnetik Inti (NMR) dan Analisis Gravimetrik Terma (TGA) boleh digunakan bagi mengenalpasti ciri-ciri terperinci selulosa dan glukosa yang telah dihasilkan daripada habuk kayu.

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ABSTRACT

Disposing of solid waste had become the great challenges in today's world. Thus, there is an urgency to transform the solid waste into an added value product. Sawdust is one of the solid wastes which can be hydrolyzed into glucose. This research focuses on the effect of sawdust species and particle size during glucose production. Three species of sawdust have been chosen in this research which was *Meranti*, *Keruing* and *Kempas*. Each species of sawdust were prepared in four different particle sizes which were 160 μm, 200 μm, 315 μm and 630 μm. After several steps of pretreatment to recovery the cellulose from the sawdust, enzymatic hydrolysis method was used to produce glucose from cellulose. The highest cellulose recovery was obtained from the *Keruing* species with the particle size of 630 μm. Furthermore, the highest glucose production after the enzymatic hydrolysis was *Keruing* species with the particle size of 200 μm. From this research, it is recommended that Nuclear Magnetic Resonance Spectroscopy (NMR) and Thermal Gravimetric Analysis (TGA) can be used to determine the detail characteristics of cellulose and glucose that has been produced from sawdust.

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF PROPOSED STUDY

According to national statistics, Malaysia generates about 2.18 million tonnes of wood waste per year. This wood waste can pollute the environment especially in Malaysia. Sawdust is a by product or wood waste of wood processing, hence using the sawdust can help to decrease the problem of disposal solid waste which has negative impact to the environment. Sawdust is one of lignocellulosic biomass which can be used as renewable resources for production of glucose and can be further converted to ethanol or other products. For production of glucose from the lignocellulosic biomass, there are several processing methods that are currently been used. The enzymatic hydrolysis is one of the methods to convert the cellulose to glucose. Some pretreatment process should be applied before the enzymatic hydrolysis.

1.2 PROBLEM STATEMENT

Disposal of solid waste has become the great challenges in today's world. Sawdust is a by product or solid waste of wood processing. Malaysia is one of the producers of wooden product in the world. Many species of hardwood can be found in Malaysia's tropical rain forest. Thus, variety species of sawdust from hardwood are produced when processing the wood. Besides, there is a lack of study about hardwood sawdust species and its particle size on glucose production.

1.3 RESEARCH OBJECTIVE

1.3.1 To investigate the effect of sawdust species which can lead to cellulose recovery.

1.3.2 To find out the effect of sawdust particle size to cellulose recovery.

1.3.3 To determine the effect of sawdust species and particle size on glucose production.

1.4 SCOPE OF PROPOSED STUDY

1.4.1 Sawdust was collected from Seng Beng Sawmill Sdn. Bhd. at Gambang. Once the sawdust was taken from industry, the sawdust needed to be dried under the sunlight about five hours to eliminate water content in sawdust. Pre-delignification process was run for sawdust to remove all the oily content, grease and dirt content. Then, first and second stages of pre-treatment process were applied to the sawdust to remove the lignin content and hemicelluloses.

1.4.2 Three species of sawdust species (*Meranti, Keruing and Kempas*) with the particle size (160 µm, 200 µm, 315 µm and 630 µm) were investigated in this study. Sieve shaker was used to get varying particle size of sawdust on glucose production.

1.4.3 The research was limited within a scope which consists of examination of glucose production from sawdust by enzymatic hydrolysis. Two types of commercial enzymes were used; Cellulase (C6105) and Cellobiase (C2730) which were purchased from Sigma Aldrich (M) Sdn Bhd.

1.4.4 After the enzymatic hydrolysis, the glucose was produced from cellulose. In order to analysis the glucose in the solution, the biochemical analyzer was used to detect the glucose which present in the solution. Fourier Transform Infrared (FTIR) and Scanning Electron Microscopy (SEM) also used for analysis in this study.

1.5 SIGNIFICANCE OF PROPOSED STUDY

The significance of this research was to decrease the problem of disposal solid waste which has negative impact to the environment by converting sawdust to glucose. Beside, the sawdust species can be explored in this research. The effect on species of sawdust and particle size to produce highest cellulose and highest yield of glucose can be achieved in this study. Enzymatic hydrolysis which was used in this study not only friendly to environment, this type of hydrolysis also has better conversion from cellulose to glucose. The glucose which generated from the hydrolysis of wood sawdust can perform as sweeteners and suitable use in food industry.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION OF GLUCOSE

Glucose is one of the carbohydrates and it is a simple sugar which is call monosaccharide. It forms water soluble, odourless, colourless and sweet crystal. Moreover, it can found in the plant and can be form in human body by hydrolysis of starch, cane sugar, maltose and lactose (Saxena, 2006). Molecular formula of the glucose is $C_6H_{12}O_6$ and its chemical structure is shown in Figure 2.1.

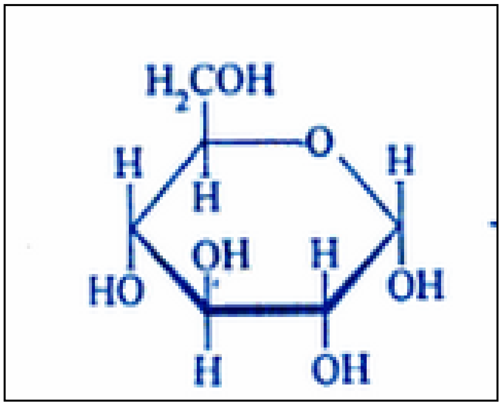

Figure 2.1 Structure of glucose (Das, 2012)

2.1.1 Importance of Glucose

Glucose is the most abundant monosaccharide in the world because it is energy sources for all living cell. In plant and microorganisms, glucose and other sugars act as nutrient and be a 'signaling molecular', exerting transcriptional control over many nutrient transporter genes. Furthermore, glucose can also be alter mRNA and protein when it as an extracellular sugar (Mobasher et al., 2008).

Glucose is also an important substrate for all mammalian cells and is an energy source for cellular metabolism. Inside the mammalian body, glucose can provide carbon skeletons for the biosynthesis of other macromolecules like lipids, proteins, nucleic acids and complex storage polysaccharides which are glycogen. Besides, glucose is the building blocks of glycoprotein like proteoglycan which is the structural components of the extracellular matrix mineralization that fulfils adhesive and informational function (Mobasher et al., 2008).

Glucoses are stored inside of animal and fungi in the form of glycogen. In human, those glycogens are store in the liver of human body. While, glucoses are form a storage polymer name as starch in the plant (Wertz et al., 2010). Glucose is used as an energy source in most of the organisms including human being. Besides, the glucose can form disaccharides when two monosaccharide linked together by glycosidic bond. The examples of disaccharides are sucrose, lactose and maltose.

2.1.2 Application of Glucose

The sucrose can be formed by glucose and another monosaccharide which is fructose (Figure 2.2). It also can call as “table sugar”. The molecular formula of sucrose is $C_{12}H_{22}O_{11}$. It is an important ingredient for many foods like cakes, candy, ice cream, cookies and biscuits.

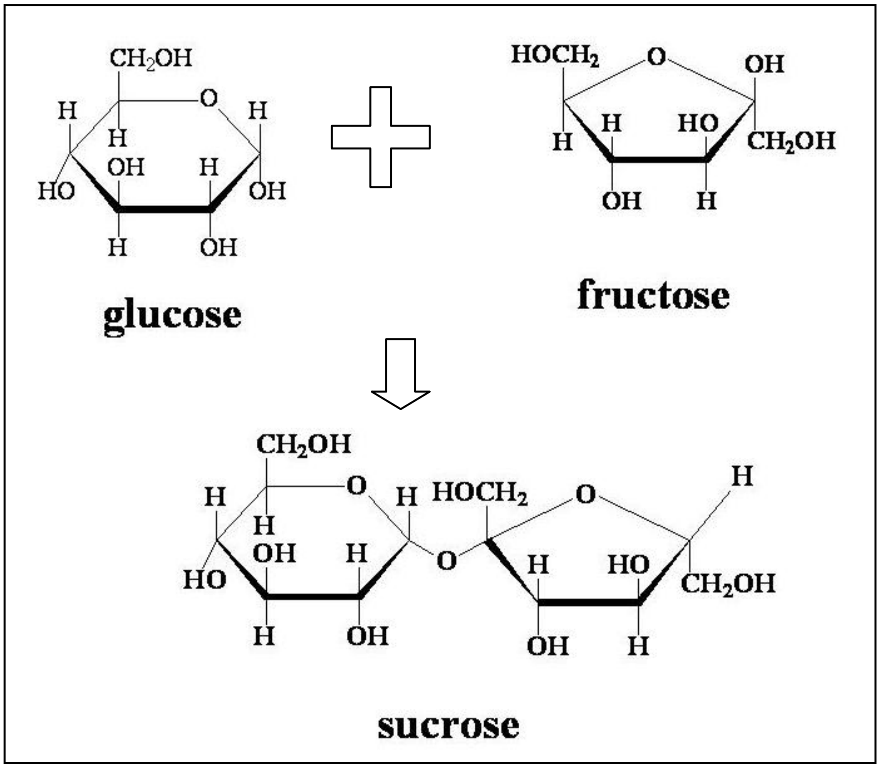

Figure 2.2 Formation of sucrose (Das, 2012)

Another disaccharide is lactose which is composed of glucose and galactose (Fiigure 2.3). This disaccharide normally can be found in the mammal milk. In the manufacture of pharmaceutical, lactose is used as filler binder for pharmaceutical capsules and tables. This is because lactose is low hygroscopocity, bland taste, and cost effective (Guo, 2008).